View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Lincoln University Research Archive

Science, Society, and Water Resources in New Zealand:

Recognizing and Overcoming a Societal Impasse

Edward P. Weber, Washington State University
Ali Memon, Lincoln University (New Zealand)
Brett Painter, Lincoln Environmental Research
at Lincoln Ventures Ltd (New Zealand)

Accepted for publication in *Environmental Policy & Planning Journal*

ABSTRACT

The Canterbury Regional Council, which manages 70 percent of New Zealand's irrigated land, has struggled to control the burgeoning demand for water resources as more land is converted to highly profitable, water intensive dairy farms relying on groundwater. At the center of Canterbury's struggle over water resources and its effective management are two competing groundwater science models. The different approaches and their implications for water management have led to a situation commonly described as a "science impasse" with scientists, policymakers, and stakeholders increasingly focused on "how to break the gridlock over science," particularly in one of the region's major watersheds, the Selwyn. In keeping with the traditional logical positivist, linear approach to science the expectation is that if the scientists can get the science right, then the ultimate goal of water sustainability will be made more likely since the "facts" will guide policymakers toward proper decisions. Yet our research found that while stakeholders do focus tightly on the dominant role of science and scientists when discussing solutions to the impasse, the underlying reality is a societal impasse grounded in the overarching adversarial setting, the logic of the wicked problem set, and the ultimate goal of sustainability. Seeing the "impasse problem" from this new perspective means that getting only the physical science right addresses the symptoms, not the underlying causes of the impasse. The article develops why the traditional instrumental, linear approach to science is unlikely to work in this case and why an alternative approach to science—civic science—offers promise as a way forward. A final section turns to the kind of steps most likely required to transition the Selwyn watershed's "societal impasse" dynamic from an adversarial setting to an effective collaborative governance arrangement conducive to the civic science enterprise.

New Zealand's (NZ) Resource Management Act 1991 (RMA) emphasizes integrated environmental management and gives primary responsibility for water resource planning to 16 elected regional councils. Councils with watersheds approaching their water allocation potential, coupled with the increasing incidence of non-point source water pollution, are experiencing difficulties discharging

this role effectively (Ministry of Environment 2004; Memon and Skelton 2007). The Canterbury Regional Council—Environment Canterbury (ECan)—which manages 70 percent of NZ's irrigated land using 60% of all water allocated for consumptive use in NZ, is no exception. In the Selwyn watershed of Central Canterbury, ECan has struggled to control the burgeoning demand for water as more dryland farms (mainly sheep) and plantation forests are converted to more profitable water intensive dairy farms relying on irrigation from groundwater. These trends coincide with a period of lower than average rainfall. The result is that lowland streams now experience low or no flows for significant portions of the year.

At the center of Canterbury's struggle over water resource management is the science that maps the hydrogeological characteristics of the region. Most dairy farmers, irrigators, and developers prefer a physical processes computer modeling approach--the "Aqualinc" groundwater model. Aqualinc divides the region into a series of cells and attempts to model each cell as accurately as possible. The fitting of this model to measured data (calibration) has suggested the presence of less permeable layers which could lessen the immediate impact of taking water from deeper aquifers on upper aquifers. Such a finding supports the continuing withdrawal of groundwater.

ECan, on the other hand, along with environmentalists, many urban residents of Christchurch, and other stakeholders, back a different computer modeling approach--the "bathtub" model. The "bathtub" model takes a "big picture" approach that proposes relatively continuous flows between aquifers, thus implying that a withdrawal from one area immediately impacts water levels and availability throughout the entire region. Thus, the low and no water flows in the lowland streams are viewed as directly connected to the many new water abstractions throughout the region irrespective of location. This science model supports the view that a water crisis exists or is just around the corner. The different science-based models and their implications for management have led to what

many now call a "science impasse." Both sides are convinced that their respective approach should guide water management decisions and policies.

The idea of an impasse runs contrary to the traditional logical positivist, linear approach to science in the policy process that is based on a rational planning model. Implicit to this line of reasoning is the belief that allowing scientific experts to sort through the science without interference from the bias inherent in political battles will lead to objective, empirically verified and authoritative conclusions grounded in facts. And getting the facts—the science—right contributes directly to the ultimate goal of water sustainability because the facts will guide policymakers toward proper decisions on water plans and water abstraction applications. Yet, in the Selwyn watershed Canterbury's scientists, policymakers, and stakeholders cannot agree on the science, which has left water resource decision processes dominated by legally-driven adversarialism and ultimately gridlock.

Given the "science impasse," we interviewed key scientists and stakeholders involved in the allocation and management of groundwater resources in the Selwyn watershed during 2009. What we found were two lessons of value to the public management literature. First, we found that the framing of the problem directly influenced respondents' choices of paths out of the impasse. Unsurprisingly, the alternatives drawing the most support were focused on "getting the science right." Hardly anyone stopped to offer paths forward that stepped outside the realm of science and scientists. More important than this, however, is our second finding. Despite the tight focus on science and scientists, there was a strong tendency on the part of *every* interviewee to lean on social, economic, legal and political considerations as causal explanations for the science impasse.

This leads us to argue in this paper that that the problem has been framed incorrectly as a "science" problem, when in fact the problem is a "societal impasse" grounded in the adversarial institutional and societal dynamics within which the stakeholders are acting. The consequence of this conclusion is that getting an ICM (integrated watershed management) plan that achieves

sustainability over the long-term must necessarily address more than just the science in order to get beyond the current impasse; the plan must also address the social dynamic *and* the economics *and* the political-legal setting (Berkes, Colding, and Folke 2006; Dietz and Stern 2009, vii, 9-16; Kates et al. 2001). Seeing the "impasse problem" in Canterbury from this perspective means that *getting only the physical science right addresses the symptoms, not the underlying causes of the current "science impasse" or the key constraints on achieving sustainability/non-sustainability*.

The article proceeds by laying out stakeholders' ideas for breaking the gridlock in the Selwyn watershed, along with a discussion of stakeholders' assessments of their viability. A second section develops why the traditional instrumental, linear approach to science is unlikely to work in this case and why an alternative approach to science—civic science—offers promise as a way forward given the overarching adversarial setting, the logic of the problem set, and the ultimate goal of sustainability. Civic science emphasizes a multidirectional and iterative flow of information among scientists, policymakers, citizens, and other societal stakeholders for the purpose of reconciling and better managing the supply, demand, and use of scientific information in the policy process (Dietz & Stern, 2009; McNie, 2007; Schmandt, 1998). Yet, given the adversarial reality of the "societal impasse" in the Selwyn case, additional steps need to be taken in order to create a decision-making context conducive to the civic science enterprise. More specifically, we suggest that the likely best path forward is for ECan and the other stakeholders to credibly commit themselves to a non-statutory collaborative[1] problem-solving arrangement in which ECan sets the broader, overarching goal of sustainability as defined above, yet equitably shares power with major stakeholders and citizens in the actual discussion, negotiation, and writing of the ICM plan. This is because, as the recent scholarly literature makes clear, a collaborative, deliberative engagement with stakeholders of place facilitates the discovery of common ground, creates ownership in joint decisions, and increases trust, with resulting benefits in the sustainable use and management of natural resources (e.g., Dietz and

Stern 2009; GAO 2008; Kates et al. 2001; Ostrom 1990; Warner 2007; Weber 2003). The key challenge thus becomes facilitating a transition from the adversarial subsystem dynamics to a collaborative one capable of effective, long-term conflict resolution (Sabatier and Jenkins-Smith 1999, 150; Mitchell 2007; Tattersall 2010; Weber 1998, 2009). Once the plan has been formulated and agreed to on a consensus basis, then ECan, which will have been involved along each step of the collaborative process, can implement it via their RMA and Local Government Act (LGA) mandates.[2] We acknowledge that there are some initiatives already underway at the regional, watershed, and sub-watershed level and a stated intent by ECan management to support collaborative governance at the regional and watershed levels under the umbrella of the recently adopted *Canterbury Water Management Strategy* (Canterbury Water. 2009). We therefore seek to aid these processes through constructive analysis of the current situation and the articulation of lessons learned from the collaborative governance literature. On this last point, the article is designed to offer advice on the kinds of steps that will facilitate the kind of collaborative governance capable of successfully supporting the application of the civic science approach.

Moving Beyond the Science Impasse

Stakeholders in the Selwyn watershed of New Zealand proposed a number of possible paths forward for resolving the science impasse.

More and Better Science

The first path was agreed to as necessary by all those interviewed: undertake new science and metering initiatives in order to produce more and better information about water resources and hydrogeology (groundwater), in particular. The irony here is stakeholders expect that the new,

"better" science will necessarily reduce the inherent uncertainties in the current science, thus making the science more accurate. Greater precision, according to this view, increases the likelihood that the science will become an authoritative reference point capable of conjuring substantial agreement among those currently battling over the science. Seen from this perspective the problem with the existing science models is that they are incomplete and inaccurate.

Create and Use an Authoritative Multi-Disciplinary Science Review Panel

A second popular path forward is the creation of a multi-disciplinary, multi-member scientific peer review panel that sorts through and authoritatively judges the science on offer. A good–sized minority of stakeholders suggested that at least some of these scientists need to come from outside New Zealand given that so many of the existing New Zealand-based experts are already identified with one side of the impasse or the other.

The second alternative addresses several key problems with the current decision making process. Some of the science currently in dispute is not peer reviewed, or is peer reviewed by scientists hired by applicants, which many see as a clear conflict of interest. Given this, the quality of the science typically under review in the court hearing process, or by the Environment Court itself, may, or may not be the "best available" science on the issues in dispute.

As well, the current statutory hearings process can give a single scientist on the local authority, or the Environment Court hearing panel, considerable influence over the outcome (Memon and Weber 2010). In cases of high uncertainty (low precision as to cause and effect), which is the case with groundwater in the Selwyn, such a expert, even if not trained in the multiple fields of science expertise required to understand the full complexity of the wicked problem set, still gets to decide which side has the best science. This means that the current "science review" process ignores a considerable body of research over the years demonstrating that scientists, and other types of

experts (e.g., lawyers), suffer from analytical bias tied to their training (Barke and Jenkins-Smith 1993; Cohen 2006) and the career-based incentives associated with their professional affiliations (Khademian 1992). To the extent that a scientist "share[s] similar theories and methods of understanding and explaining complex phenomena," they are more likely to side with scientific research that is from their particular academic discipline (e.g., geologists' privilege geological explanations) and/or that takes broadly similar theoretical and methodological approaches to a problem (Weible 2008, 626; Kuhn 1970). This is not to say that all scientists are purposely biased, or that "analytic bias" necessarily explains all of the reasoning behind an expert's decision, but it does mean that final decisions are dependent as much on the individual selected to sit on the hearing panel as on the science itself.

Recent Decisions and Research Findings Support a Waiting Game

Alternative number three involves ECan staying the course with its support of the "bathtub" modeling approach. The expectation here is that statutory hearings based on science evidence will start supporting this approach, thus resolving the science impasse in favor of ECan's preferred approach. This reasoning is supported by a small handful of stakeholders who believe that science and time are on the side of the "bathtub" modeling approach (interviews 3/16/09A; 3/16/09D; 3/17/09A). As one stakeholder noted, "the third [independent hearing] decision [Selwyn-Waimakariri] seemed to indicate that the Environment Court was starting to doubt the science affirmed in the first two cases by attaching restrictive conditions on new water consents" (interview 3/17/09A**).** Following the Selwyn-Waimakariri hearing, ECan mandated a new form of 7-day pump test in which applicants seeking groundwater consents must demonstrate that the requested water exists before a consent can be lodged. Drilling and testing costs can run into the hundreds of

thousands of dollars and some applicants have raised concerns that they may not be able to borrow this money under such risky conditions. Court action was considered likely as of March 2009.

Some also point to 2008 "leakage test" data showing the presence of as high as 50% leakage rates in areas between known aquifers, thus showing support for the significant connectedness, or water transmissivity theorized by the Selwyn "bathtub" model (interviews 3/16/09A; 3/16/09D). Others, however, were quick to note that ECan's assumption that the leakage "comes from above [and thus supports the connectivity thesis] is still a hypothesis…..it may have its source from a lateral position or it may be pressurized and is coming up from lower" in the geological formation (interview 3/20/09D; 3/16/09B; 3/16/09C; 3/20/09C). At a minimum, this new data, rather than settling the science, appears to be feeding the impasse. The meaning of the newly discovered leakages rates is not settled by any means.

Others point to a series of "failed" pump tests conducted during September and October 2008 as a reason to be optimistic about the "bathtub" modeling approach gaining new life in the months and years to come. Yet, while a local Christchurch newspaper reported the "failures" and ECan was quick to alert the public about them, other stakeholders dispute the conclusion and argue that, given established testing guidelines and flow parameters, "these pump tests did not fail" (interviews 3/17/09B; 3/17/09C; 3/20/09C; 3/20/09D; 3/20/09E).

Another area of optimism for the "bathtub" proponents concerns the July 2008 Valetta-Ashburton River independent judicial hearing in which Jon Williamson, an expert witness (scientist), reportedly "did serious damage to the Aqualinc groundwater model in this hearing" (interview 3/17/09A). However, as with the "leakage rates" and the reported "failed" pump tests, this conclusion is disputed and, according to some, the witness "discovered some minor flaws in the Aqualinc model…. struggled to defend some of his own conclusions, and focused most of his case on science having little or nothing to do with the model itself" (interview 3/20/09D).

Develop ICM Plans within the Constraints of the Aqualinc Modelling Approach

In this fourth alternative, ECan accepts that their "bathtub" approach is correct and works to develop and implement policies designed to achieve sustainability within the constraints of the Aqualinc approach (interviews 3/12/09A; 3/12/09B; 3/16/09B; 3/17/09B). The argument is that there is nothing inherent within the Aqualinc modeling approach that suggests its parameters and conclusions are antithetical to sustainability. Moreover, proponents of this possibility note that the Aqualinc model has undergone two major "reworkings" to date and is constantly adding new data in an attempt to improve its accuracy (interview 3/20/09C; even its detractors give it this much credit, 3/17/09A).

Finally, these stakeholders point to the pattern of support by the Environment Court for the "better science underpinning the Aqualinc model and little, if any support for the science behind the bathtub model to date" (interview 3/12/09A). Thus, they expect judicial expert hearings and court decisions more likely than not to continue favoring the Aqualinc model as "the science" for deciding water consent requests, and hence a prudent path forward for allocation management and ICM decisions would be to innovate within the existing constraints provided by the legal system.

Recalibrating the Nature of the Impasse: Is the Impasse about Science or Something Else?

While key stakeholders in Canterbury perceive the above four options as viable paths for resolving the science impasse, their discussions of the various alternatives also display strong skepticism that any of them will work. Interestingly, the skepticism is grounded less in the science itself, than in the larger political, legal and economic forces enveloping the science and the scientists. The societal pressures and stakes are such that virtually all the information in the Selwyn science impasse is viewed through the political-economic prism of who is presenting the information, which interests they represent, and what they have to gain from their "scientific" conclusions.

For example, no one believed that ECan will ever accept the current Aqualinc model unless it is forced given the "passion of the leadership" and other stakeholders for the "bathtub" model and the accompanying belief that it already has the science right (interviews 3/12/09A; 3/16/09B; 3/20/09 C; D; E). As one stakeholder stated, "how can ECan support [Aqualinc]? They cannot give away half of the public's water to developers" (interview 3/16/09D). To others, it is clear that ECan has adopted a "siege mentality in defense of the bathtub model" (3/17/09B; 3/12/09A), thus accepting and using the Aqualinc model would require a dramatic change from their current position, along with significant culture change within ECan in order to make this alternative work.

Political-economic considerations also encompass the "waiting game" strategy preferred by ECan. Most saw this as a high risk strategy unlikely to pay off given that the new information and hypotheses informing this strategy had yet to be tested in court. The ECan strategy was questioned by some given that the hearing commissioners appointed to recent hearing boards had maintained support for the Aqualinc model. In fact, several stakeholders were "baffled as to why ECan keeps on supporting the Selwyn bathtub model. The Environment Court and the two hearing panels found against it." As explained by one respondent, "the bathtub model is really more conceptual than anything; it has not been empirically tested and is simply not as convincing as the Aqualinc model, although the Aqualinc model is not perfect by any means" (interview 3/17/09B; 3/12/09A; 3/12/09B). Others, including supporters of the ECan position, point to the fact that the Selwyn bathtub model still has not resolved the "effects" challenge when it comes to long distances (i.e., upper watershed water abstractions versus lowland stream effects) (interviews 3/16/09B; 3/17/09A; 3/20/09D). Still others see the ECan perspective on science as being about politics: "ECan is driven by politics to make certain decisions. The problem is that they have put themselves in a position where the science does not support their position" (interview 3/20/09D). In short, according to most stakeholders we interviewed, adopting the waiting game strategy is likely to feed the impasse because it is viewed as a

"head in the sand approach that is more about wishful thinking than reality" (interview 3/20/09C), and as such, will most likely create additional mistrust, division, and litigation.

The science panel proposal suffers a similar fate. Every stakeholder except one expressed agreement that the science panel will *not* work if it is convened *after* a dispute is already in progress. This is because despite New Zealand Environment Court and local authority hearing strictures giving scientists a role as neutral officers of the court, most stakeholders' experiences have led to deep cynicism about "the impossibility of untangling client-scientist relationships that give scientists strong incentives to support their client's preferred policy goals. This is true whether we are talking about scientists in the private sector or with ECan" (interview 3/17/09B). As one stakeholder scientist noted: "All people, despite their best intentions, are captive to their upbringing, to their own interests, to their professional training, and their own organization" (interview 3/20/09A). Nor is it clear that local scientists will sign their name to any public agreement on science for the client relationship reasons noted above. In fact, an attempt to work out the impasse with 14 scientists behind closed doors in February 2007 resulted in all but two scientists agreeing to just such a public statement of common scientific ground (ECan 2007). Yet, within 24 hours, one scientist called back in and withdrew his support after apparently receiving pressure from clients (interview 3/17/09A).

As well, the idea of expanding local authority hearing panel membership to individuals outside the region, in this case the North Island of New Zealand, is seen as problematic given that some have already been involved, that they are not viewed as experts in Canterbury groundwater science or geology by some, and that they are now seen by several key stakeholders as "having taken sides in the ongoing battle among the developers and regulators" (interview 3/20/09C). Moreover, going outside New Zealand for scientist-experts may well add an authoritative imprimatur to any scientific conclusions, but may also suffer from the same concerns as the North Island experts noted above and will most likely be contested fiercely if their conclusions do not accord with key

stakeholding groups. Finally, adopting the science panel approach would also require agreement on rules for who appoints panel members, how many scientists, what disciplines, and so on. In the current environment of low trust and entrenchment, the likelihood of agreement on such rules is very low and perhaps an impossibility.

When the issues associated with the first three potential science-based solutions to the impasse are coupled with the reality that there may always be significant uncertainties associated with the groundwater science in this case, it makes little sense to think that the impasse can be resolved based on science alone. Put differently, more and better information may be a necessary condition for resolving the impasses, but it is not a sufficient condition for doing so. In short, given the context of suspicion, distrust, and the perceived self-interest of the stakeholders and scientists involved, it is impossible to "get the science right," since many will not believe it even if it is technically correct. Thus the root of the impasse problem is not science per se; rather it is the competing interests of the major societal stakeholders.

Rethinking the Role of Science in the Policy Process

In recent decades, it has become clear that science and scientists/experts no longer hold sway as unquestioned authoritative sources of objective information in many high stakes policy debates. This loss of influence has led to growing frustration on the part of government agency officials and scientists over their inability to have science exert as meaningful a role as they think appropriate in the consideration and selection of policy alternatives (Pielke 2007; Jasanoff 1990). Part of the decline stems from the growing realization that many public problems emerge out of "complex patterns of overlapping consequences," including those of social and cultural import, thus effective solutions "will require more than technical solutions" (Lane 1999). Moreover, the growth industry of adversarial science, or "scientists as gladiators," and declining trust in government and expertise,[3]

more generally, have only exacerbated the "science and policy" problem by doing harm to scientific and government agency claims of objectivity and/ or decisions made on behalf of broad public interests (Carnavale 1995; Nye 1997; Williamson 2008). The "scientists as gladiators" phenomenon is most evident in adversarial subsystems composed of the following characteristics.

> [Competing] coalitions will diverge in their analytical approaches to problem solving and in their perceptions of uncertainties and risks. Coalitions will use uncertainty and risk to boost their preferred policy image or to challenge a policy image of a rival coalition. Because of the political value of expert-based information, experts will become central allies in their coalition. Consequently, experts will also become central opponents to a rival coalition. Learning will reinforce beliefs within coalitions and among experts with similar analytical approaches (Weible 2008, 628).

Thus, it is not at all surprising to hear a scientist involved in the Canterbury impasse state that "[u]ntil you get agreement among the clients [the stakeholders], it is highly unlikely you will get solid agreement among the scientists who work for them" (interview 3/17/09A).

More important for the Selwyn watershed in Canterbury, and other areas facing similar problems, is the larger conclusion of the literature:

> There is an emerging consensus regarding the need to look for broader approaches and solutions, not only with resource and environmental issues but along a wide front of societal problems…. [This requires that] [s]cientific solutions be undertaken with greater attention to their social context … and created through processes of co-production in which scholars and stakeholders interact to define important questions, relevant evidence, and convincing forms of argument … [This is the case given that such] problems are … *complex systems* problems … whose causes are multiple, diverse and dispersed and cannot be understood, let alone managed or controlled through scientific activity organized on traditional disciplinary lines (Berkes, Colding, and Folke 2006; 1-2; see also Kates et al. 2001; Weber and Khademian 2008a).

In sum, the "societal impasse" involving water resources and associated environmental management issues within the Selwyn watershed of New Zealand's Canterbury region clearly fits as the type of problem requiring an alternative approach to science in the policy process. It is a case of "soft" and complex environmental, economic, legal, and social systems populated with wicked problems that are relentless, cross-cutting, and unstructured (rife with uncertainty) **(**Roberts 2000; Weber and Khademian 2008a**)**. This means that the problems never fully go away and that many

stakeholders with competing interests and worldviews (values) are involved. It also means that there are inherently high levels of uncertainty, whether with respect to the science that tries to model and understand the biophysical relationships, the human/stakeholder relationships, or the policy and planning frameworks and outcomes across the full spectrum of interconnected issues. Thus, successfully achieving "sustainability and management of regional resources are not [just] an ecological problem, nor an economic one, nor a social one. They are a combination of the three" (Hollings 2006, xviii). As such, there is general agreement that traditional top-down, one-way (from scientists to others), instrumental, and linear models for conceptualizing the role of science and scientists in the policy process are not capable of capturing the changed political, social and "scientific" realities of the contemporary Selwyn watershed context for policymaking.

These same scholar-scientists, along with many policymakers, have gravitated to the concept of civic science/scientists—"efforts on the part of scientists to articulate and illuminate science content in the context of social issues"--as a new and improved model for integrating science effectively into the policy process (Clark and Illman 2001, 18; Lane 1999; Pielke 2007; Pielke and Sarewitz 2005; Schmandt 1998; Stokes 1997).

Kai Lee (1993) was one of the first to call specifically for "civic science" to guide decision-making for salmon recovery in the Columbia Basin region of the U.S. and Canada. Stokes (1997), for his part, rejects the standard "basic versus applied" research dichotomy for most problems as overly simplistic (70) and instead argues for the significant value added by a civic science grounded in use-inspired *basic* research that "seeks to extend the frontiers … of the more general understanding of the phenomena of a scientific field, … but is also inspired by considerations of use" (74). Pielke (2007) argues that scientists and science organizations are likely to be more effective once they adapt their roles to the inherent limits and opportunities of science as related to different problem solving contexts. Of particular importance to Pielke is the civic scientist who adjusts their role to that of an

"honest broker" in cases where value consensus is low and scientific uncertainty high (2007, 17-20). Schmandt's (1998) version of civic science "is the process of linking experts and stakeholders in planning social, economic, and environmental improvements" (63), while Pielke and Sarewitz (2005) seek to improve the usability of science through communication, due consideration of institutional context, and the matching of science supply with societal demands.

The combined logic of the problem set, the overarching goal of sustainability, and the civic science model leads strongly in the direction of networked, or collaborative, governance "processes that link sound scientific analysis with effective public deliberation" (Dietz and Stern 2009, vii; Berkes, Colding, and Folke 2006; Kates et al. 2001). At the same time, it is important to realize that collaboratively based networks, with their emphases on conflict resolution processes, inclusiveness, and information sharing have assumed a place of prominence in the literature of public and private governing structures. These inroads into the literature have gradually nudged government-based hierarchies and markets as the foremost means for organizing to address complex problems, share scarce resources, and achieve collective goals (Peters 2001; Powell, Kopet and Smith-Doerr 1996; Kickert, Klijn, and Koppenjan 1997). Moreover, the actual embrace of collaborative approaches to natural resource management at the watershed scale around the globe is a strong theme in the recent planning and environmental management literatures (GAO 2008; Mitchell 2007; Pretty 2004; Sabatier et al. 2005; Warner 2007; Weber 2003). As Weible (2008) explains, in its ideal form,

> collaborative … subsystem actors will seek to integrate local information and expert-based information in consensus-based institutional venues. Actors will recognize the limits of information and proceed adaptively through joint fact-finding strategies. Cooperation across coalitions will coincide with cooperation across different analytical methods of inquiry. The result will be interdisciplinary approaches to problem solving. Scientists will continue to be coalition members, but their centrality … will decrease (627-628).

Thus our earlier suggestion that ECan and other Selwyn watershed stakeholders credibly commit themselves to a non-statutory collaborative problem-solving arrangement in which ECan sets

the broader, overarching goal of sustainability, yet shares power with major stakeholders and citizens in the actual discussion, negotiation, and writing of the process outcomes. The key question that drives the rest of this analysis thus is: how do ECan and the other stakeholders move on from the current adversarial situation in order to maximize the potential of collaborative governance arrangements conducive to the civic science enterprise?

Moving from Societal Impasse to Effective Collaborative Governance and Integration of Science

Getting the collaborative arrangement up and running effectively given the current conditions of acrimony, lack of trust, longstanding factual and interest-based disputes, and a situation where not everyone acknowledges that Canterbury may have a water problem, much less a need to act on it, will not be easy. This is because assuring the performance of others in order to realize positive sum "mutual gain" outcomes in collaborative settings is a highly uncertain endeavor (Weber 1998). Participants must be convinced that others are not simply using the collaborative format to advance hidden agendas, and that sharing private information, negotiating compromises with strangers and known adversaries, and risking *ex post* breaches in agreements will not come back to haunt them.

The challenge for stakeholders is how to cut through the uncertainty and change the risk calculus for stakeholders to "what can me and others, including our communities and the environment, gain?" This approach accepts that deep seated value conflicts are not going away, that self-interest is a key motivator for human behavior, and that the differences in stakeholder interests and goals are legitimate. How can the uncertainty found in natural resource policy situations such as Canterbury's be minimized, thus increasing the probability that stakeholders' individual goals and the community's collective goals (sustainable water management) will be achieved, and thereby inducing stakeholders to engage and support the collaborative in a good faith effort?

Increasing the likelihood of overcoming the collective action dilemma and sustaining successful collaborative problem solving involves identifying the *process* design elements that are most likely to minimize the uncertainties associated with collaboratives by creating for participants a genuine stake in decision processes and outcomes, an environment of trust, an opportunity to discover shared values, and an increased certainty that cooperation will lead to preferred benefits. With respect to trust, the operating assumption for a wicked problem scenario is that there will be little or no trust at the beginning of the collaborative process given inherent participant diversity, hence conflicting values and interests, and a good chance that at least some participants will be unfamiliar with their new collaborative partners. A critical process task thus involves cultivating enough trust to promote cooperative behavior and agreement on policies, programs, and the information informing such decisions. In short, resolving the societal impasse necessarily also increases the probability of successfully producing, integrating and applying a broad knowledge base to the collaborative governance efforts.

Toward this end, the following institutional process factors appear to increase the probability for transitioning to successful cooperation on policy and a civic science approach.

- Inclusiveness (Daniels and Walker 2001; O'Leary, Durant, Fiorino, and Weiland 1999);
- A common sense, strategic approach to early problem solving (Weber 2008);
- Credible commitment (Cheng and Daniels 2005; Weber 2003);
- Participant norms (North 1990);
- Formal binding collective choice rules with a purpose (Ostrom 1990; Weber 1998);
- Collaborative capacity building leadership (Weber and Khademian 2008a; 2008b);
- A hurting stalemate (Sabatier and Jenkins-Smith 1999, 150).

Inclusiveness

Successful collaboratives must include a broad-cross section of stakeholders across interests, governmental jurisdictions, and agencies with responsibilities for the wicked problem set in question.

The inclusivity factor is important for reasons of democratic legitimacy and practical considerations related to problem solving and policy implementation. With regards to the former point, achieving inclusivity requires collaboratives to practice government in the sunshine. This means an open access design that welcomes interested parties, and that encourages and allows a broad array of citizens and government officials to participate in proceedings, including "outsiders" who may only wish to monitor and report on collaborative activities to those outside the community where the effort is occurring. "Open access" also voluntarily endorses the community's right to know about its proceedings, decisions, and projects by giving public notice of meetings, providing public access to meeting minutes, creating pertinent databases associated with decisions and projects, sponsoring public field trips, and, more generally, engaging the public through regular outreach activities.

At the same time, pragmatism suggests that all stakeholders in a position to block or effectively undermine outcomes must be included and given a credible stake in the collaborative. Otherwise, collaborative participants encounter added uncertainty and face a greater likelihood of failure, as those left out mobilize resources in defense of their stakes. Failure to practice inclusion thus lessens the probability that implementation and the establishment of the kinds of durable, effective policy programs able to deliver long-term problem solving benefits will occur.

A Common Sense, Strategic Approach to Early Problem Solving

In watersheds involving stakeholders with diverse backgrounds and interests who have been engaged in ongoing battles, the first task is to rebuild the frayed relationships and establish enough trust to get people talking and sharing the kinds of information necessary for managing and hopefully resolving the many public problems facing watershed communities. Weber (2008) establishes five key components to this approach to early problem solving. The good news for the Selwyn watershed is that some progress has been made in this area, in particular through the collaborative development

of a future vision for a lake at the base of the Selwyn watershed,[4] and through the formation of SWALG—a multi-year water management research collaborative involving a variety of relevant disciplines and knowledge sets (Ti Koura Consulting 2008). Integrating linkages are also being created with relevant collaborative initiatives at sub-watershed and regional scales under the guidance of the *Canterbury Water Management Strategy* (Canterbury Water, 2009) .

Lead agencies adopt a non-confrontational public outreach approach to key stakeholders. This element specifically recognizes that trust-based relationships are the key to long-term problem-solving success in wicked problem settings. The focus is on disseminating information that explains and clarifies the problem set in terms of problem severity, the legal parameters and obligations associated with such problems, the distribution of responsibilities for resolving the problem(s), and the pros and cons to stakeholders of various alternative approaches to problem resolution. Opportunities exist to advance such issues through community consultation that is currently being carried out for the Selwyn watershed and the Canterbury region in 2009.

Adopt a shared "cost of compliance" approach and be persistent in the search for project funding. This reinforces the "we're in this together" psychology of the partnership. It means that individual landowners do not have to shoulder the entire burden or responsibility of compliance, whether in terms of funding compliance efforts or in seeking out external funding sources.

Reduce objective uncertainties in the wicked problem setting. Collecting information, scientific and otherwise, to create a better understanding of the interdependencies and parameters of the wicked problem setting, and as a method for minimizing and removing politics from early decision-making by

creating a common base of information, is a necessary step for employing the discriminate decision strategy described below.

Exercise pragmatism when choosing problems. Pragmatism calls for attacking first those problems most likely to meet with management and implementation success (Mitchell 2007, 52). The concept is that "crawling comes before walking, and walking comes before running." The three key parts are:

- *Think politically, tread softly.* Pursue less controversial, lower risk problems so as not to engender political opposition from stakeholders. This element is best captured in what is often called an "80-20" approach to problem solving. This choice methodology focuses participant energy "on the 80 percent of problems we can all agree on, rather than the 20 percent that divide us" (interview 4/14/06A). As a result, the problems located in the 80 percent segment reduce uncertainty within the collective by posing limited political risks to individual participants' interests.

- *Adopt a discriminate, or prioritized, decision strategy*. This decision strategy targets efforts and resources at areas with the highest likelihood of investment "payback." In this sense, the new information and science is used to achieve the biggest bang for the buck. This decision approach explicitly acknowledges that resources, whether financial, human, or otherwise, are scarce, and links ecological importance and the degradation level of the "problem" in question to the feasibility and degree of "problem" improvement likely to occur for any given amount of resources applied.

- *Build a reputation for success*. Focus attention on more tractable, smaller problems as a way of increasing the probability of successful outcomes, and make headway on bigger, more widespread problems through the use of "demonstration" projects. This allows participants *and* outsiders to see tangible proof of progress, allows stakeholders and community members to benefit directly from programs, and, to the extent success occurs, makes it easier to win over skeptics and build trust for future collaborative efforts. For example, a small demonstration project poses limited risks to landowners because it allows them to see if

proponents of the new collaborative approach can and will deliver on their stated promises. Will the outcomes be mutually beneficial? Will proponents really treat their property, property rights, and traditional land uses (i.e., farming, forestry) with appropriate respect when implementing the project?

Forego short-term benefits in isolated cases for potential long-term collective gains. Decisions should avoid deterrence-based enforcement actions (e.g., punishment in forms of fines, bad publicity for violator, singling out the violator as a bad apple, imprisonment) as much as possible in lieu of encouraging people to do the right thing and physical demonstrations of how such "right things" can be done. The concept here is that such an approach will be more likely to elicit, or induce, the kinds of positive compliance responses required for programmatic success over the long term. A subset of this item involves not taking advantage of voluntarily provided private information for self-interested, short-term gains, whether in terms of compliance gains or benefits particular to any one group (see also Ayres and Braithwaite 1992; Weber 1998).

Inherent within the success of the common sense, strategic early problem solving approach is the underlying credibility of actors' commitment to the collaborative process, including their willingness to honor agreements.

Credible Commitment

The concept of credible commitment by participants entails consistency in words and actions which together evidence that a participant, along with their "home" organization, is supportive of the collaborative process and collective problem resolution (Daniels and Walker 2001, 182; Weber 1998, 113-115). Credible commitment means that participants willingly direct their power and resources to cooperate in good faith toward mutually agreeable decisions and then to promote, protect, and

enforce such deals. Thus, participants refrain from reneging on deals once agreed and do not use private information gained through cooperation for their own advantage.

As part of this, there is agreement that all representatives need enough discretion and authority to make agreements and implement decisions, or, at a minimum, need a clear chain of command that is generally supportive of the collaborative effort and has the capacity to act in a timely manner. In addition, the durability and consistency of representation across time not only signals commitment, but also increases the prospects for collaborative success by minimizing the chance of miscommunication and reducing the transaction costs associated with maintaining trust-based relationships (Sabatier et al. 2005, 195). Further, credible commitment is enhanced to the extent participants evoke a clear, strong commitment to the "place" where the collaboration is occurring, its people, and its livelihoods (Cheng and Daniels 2005, 30). Credible commitment thus requires respect for the past (no matter actors' prior mistakes), an appreciation for the present mix of livelihoods, and land tenure patterns, and a genuine concern for the goal of ensuring a sustainable future for the people, livelihoods, and place in question.[5] Finally, credible commitment to collaborative problem solving does not mean forsaking required commitments to a participants' "home" organization, interest category, or to existing laws and agency missions (Sabatier et al. 2005, 195-96; Weber 1998, 112-14). In fact, a clear, strong commitment to one's own agency or group mission is required because without it there will be little respect for the participant. The inability to make such a commitment weakens the capacity to influence proceedings, raises suspicions about where loyalties lie (i.e., what is their agenda?), and increases the chance they will be replaced by their organization, along with the probability that deals will be short-lived once the home organization learns of the apostasy.

A problem at this point in the Canterbury situation is that key stakeholders are unwilling to trust other key stakeholders given (1) the depth of the impasse and issues stemming from past water

resource battles among these same stakeholders, and (2) issues of credibility with respect to ongoing ECan sponsored collaborative efforts. On the second count, rightly or wrongly, many stakeholders argue that the reputation of ECan as a credible, trusted, fair leader or convener of collaborative governance endeavors has been tarnished in recent years. These critics see the Open Strategy and Canterbury Water Management Strategy processes as "hav[ing] been more symbolic and designed more to communicate and get others to accept a previously decided decision,… a smokescreen hiding their agenda" (interviews 3/16/09B; 3/20/09C; 3/20/09D) as opposed to good faith bargaining and credible commitment to shared governance. Another anecdote that has been shared within the community relates to a similar belief, namely that ECan seeks only the kind of information that supports its predetermined conclusions. More than one interview noted a case "where pump drilling activity stopped and the data were not recorded once much more water than expected came up the pipe" (interviews 3/16/09C; 3/20/09D; 3/20/09E). While we are unable to verify the veracity of either claim, at a minimum such comments speak to the added importance in this situation of the need for collaborative capacity building (CCB) leadership and formal, binding collective choice rules (see sections below). ECan will need to be careful in who they appoint to lead such collaborative efforts and getting the ball rolling will likely require carefully and thoughtfully structured binding rules that persuade potential participants that their time and interests will be protected.

Participant Norms

Collaborative problem solving success is more likely to the extent there is a set of well-crafted and diffused participant norms for all participants *within* the collaborative institution itself (North 1990). The norms are part of an implicit bargain individuals strike prior to joining governance deliberations and are used to communicate the message that the character of the participation matters as much or more to problem solving and trust-building than the mere act of participation. Success

here requires that leaders and individuals regularly enforce norms when violations occur, and that participants "live" the norms both inside and outside formal collaborative meetings.

Despite the agreement on the importance of participant norms, there is no one set of "must have" norms for collaborative institutions. Nonetheless, there is empirical agreement on the kinds of norms found in successful collaboratives. Some examples include civility and respect for others (and their positions),[6] integrity and honesty in communication and action,[7] acceptance of and respect for diversity,[8] acceptance of existing laws,[9] ensuring the equal opportunity to speak during meetings,[10] a pragmatic focus on the future and what is possible (versus on past battles and baggage),[11] and making sure all views are represented even if a particular interest is absent that day.[12]

Formal Binding Collective Choice Rules

While the informal constraints of credible commitment and participant norms are essential to enhancing trust and reducing uncertainty, a set of formal binding collective choice rules that govern the collaborative process and its aftermath is also necessary to restrict the ability of public leaders and other stakeholders to pursue self-interested behavior at the expense of long-term cooperation. The "rules" are grounded in four basic concepts:

- shared decision-making power, a genuine stake in the decision process and, hence, collective outcomes,
- explicit consideration of participants' interests in programmatic language and the collective choice rules,
- a written "protective" contract that identifies and arranges consequences for defections from the collaborative process, or other violations of the collective choice rules, and
- the provision of incentives that recognize unavoidable costs.

Shared decision authority grants participants a direct role in crafting and implementing programs, which gives them "the confidence to invest" in, and develop ownership of the outcomes produced by, the collaborative effort (Ostrom 1990, 93; Weber 1998, 116). The explicit consideration of interests in programmatic language often includes mandated monitoring and data reporting

systems so that progress and accountability for results are readily tracked, agreement on a standard decision-making procedure that forces decisions to consider a broad cross-section of interests and values before being accepted, and a broad, cross-cutting, balanced mission statement (e.g., protecting and preserving the health of the environment, economy and community) (Ostrom 1990, 93-94; Weber 1998, 115-116; 2003). It can also include a consensus, or near consensus decision-rule.[13] The logic here is that granting participants veto power leads to broad agreement, thereby increasing legitimacy, lowering implementation resistance, and engendering self-enforcement, while also respecting minority rights.

With respect to protective contracts, Weber (1998) notes the importance of written agreements not to litigate, or otherwise intervene to stop the implementation of jointly agreed decisions. Ostrom (1990) focuses attention on the need for binding, yet graduated sanctions because people are fallible and will make mistakes (94-96). In the New Zealand case, a formal written rule might speak to ECan's willingness to ratify and implement policies and plans once all agree. This requires the involvement and cooperation of the Canterbury Regional Council elected officials in order to make it binding.

Finally, some stakeholders, such as the Mäori and agricultural interests in the New Zealand case, will likely require additional incentives to participate in good faith, especially in cases where compliance cost burdens are likely to be considerable, are distributed inequitably, and/or involve the diminishment of a stakeholder's water usage right, and hence real or potential financial losses, for the sake of the common good.

Collaborative Capacity Builders

In the Canterbury setting, more leaders are required with the distinctive leadership style practiced by successful policy entrepreneurs (Blomquist 1992), or more specifically, collaborative

capacity builders (CCBs). A CCB is someone who either by legal authority, expertise valued within a governance setting, reputation as an honest broker, or some combination of the three, has been accorded a lead role in public problem solving exercises (Weber and Khademian 2008b).

Collaborative capacity builders have the overarching responsibility to frame the approach to problem solving and the relationships between government and other participants in the organization or network. They accept the inhospitable circumstances of heterogeneous interests and goals, as well as the uncertainties and complexities inherent in any network setting, and focus their energy on facilitating the integration of knowledge necessary for tackling difficult problems and guiding stakeholders forward to successful mutual gain conclusions (Weber and Khademian 2008a). With respect to collaboration in the Canterbury water case, this means crafting a network-based culture grounded in a credible, effective commitment to collaboration that increases the certainty that participants' stakes will be treated fairly and as legitimate claims within the broader context of sustainability goals. This requires a set of skills and traits, a reputational component, and the execution of key tasks.

The skills and traits required of a successful collaborative leader, or professional facilitator, are essentially the same, although long-term efforts aimed at institution building as opposed to simply the resolution of a single-shot problem, because they require extended, often years long involvement, tend to benefit from the sustained attention afforded by a CCB leader with clear stakes in the effort's success. They include basic traits and skills such as good communication and listening skills, respect for and ability to work with all sides of an issue, and strong people skills, meaning that the leader/facilitator is comfortable with, and skilled at, interaction and outreach involving a diversity of organizations and individuals. Nor is the CCB afraid to share power because s/he realizes this is necessary in order to get to positive sum, mutual gain outcomes (Ostrom 1990, 101; Sabatier et al. 2005; Weber 1998).

In addition, successful CCB's are persuasive and skillful enough to balance the *new* decisions of self-interested participants within the collaborative, with the needs and interests previously codified in collectively decided public goals, whether it is the RMA or other mandates. Such collaborative capacity builders are also skilled at convincing others to commit to and follow through on promises, cajole participants to stay the course when times get rough, and champion the collective, positive sum benefits of successful collaboration.

When it comes to the leader/facilitator's role, key tasks include assisting participants in discovering common ground and the benefits of collaboration by identifying prospective tradeoffs, facilitating information exchanges, and conducting the decision process in a neutral, honest, and fair manner. Implicit here is that CCBs are instrumental in convincing participants that their stakes will be protected during negotiations and decision-making, and that participants' own interests are likely to be best served by agreeing to bargain in good faith.

Given these tasks, successful CCBs also benefit from a reputation for fair play and honest, trustworthy leadership. The reputational component facilitates stakeholder willingness to move beyond negative caricatures of erstwhile adversaries and to share privately held information critical to the kinds of innovative, complex, positive sum deals found in multi-party collaborative governance situations. It also makes it less likely that outcomes will be lopsided bargains favoring one, or a few interests at the expense of others.

A Hurting Stalemate

To the extent that all stakeholders recognize problem severity and/or the characteristics of the problem solving setting as something that directly affects their ability to maximize their preferences, actors will have an incentive to choose collaboration over adversarialism (Sabatier and Jenkins-Smith 1999, 150). It is only recently in Canterbury that the outlines of a "hurting stalemate" have started to

take place, with one stakeholder acknowledging the common sentiment among the interviewees when he made explicit that "everybody is unhappy with the status quo, even the irrigators" (interview 3/20/09B). A recent change which may be contributing to a "hurting stalemate" is the transfer of considerably more financial risk to new water consent applicants, primarily developers and dairy farmers. Following the recent 2007 Selwyn-Waimakariri combined consent hearing, water applicants in the Selwyn watershed now must "prove up" their water request *prior to the consent being lodged* by drilling test bores and demonstrating through a seven-day continuous pumping test that the amount of water under consideration is physically available. The costs of such testing are significant, typically several hundred thousand dollars per test and, on occasion, running upwards of one million dollars per test. The cost, combined with the fact that the uncertainties posed by groundwater science do not guarantee that the water will actually be there, create substantial new incentives for water applicants to work together with others to resolve their differences over science and policy.

There is also potential for increasing tension between different stakeholding interests due to threats to fish populations, water supply reliability, water quality and ecosystem functioning. One stakeholder pointed to the lagged effect of nitrate pollution as a relatively new, yet serious problem that will likely only get worse over the coming years. "Nitrate pollution is showing up in the [lower watershed] groundwater. Just as the scientists predicted, it took 20 years, but now we are reaping the 'benefits' of the switch to more intensive dairying [in the upper watershed] with its higher nitrate loading problems" (interview 3/20/09A). Seen from this perspective, it would not be surprising if lower watershed farmers' concerns increased with respect to over allocated water resources and increased water pollution stemming from new groundwater consents being awarded in the upper watershed, thus giving them an incentive to seek a resolution to their dilemma. In addition, to the extent that water quality issues are becoming more of an issue in the Selwyn watershed, ECan will necessarily have more authority under existing statutes to regulate land use practices, thus increasing

costs on water users and giving them added incentives to opt for a more collaborative problem solving approach.

On the other side, ECan too has a series of factors giving it added incentives to move toward collaboration. The first and foremost among these is ongoing development pressure; water consents, large and small, are still being granted and more and more water is being withdrawn in the Selwyn watershed despite ECan's desire to slow such withdrawals.

Second, court decisions thus far have not validated ECan's preferred groundwater modeling approach and there is little indication, according to many stakeholders, that the court will be making the kinds of decisions in the near future that will do so, or that will place heavier restrictions on the water allocation review and consent process.

Conclusion

The Selwyn watershed case in New Zealand is typical of many battles over water resources in the world today. Competing interests, values and uses of water clash with the desire to improve management of an often scarce, or inequitably allocated natural resource in a world experiencing changing economic demands for goods and services along with changing policy goals—from treating water as a commodity only to a resource essential in maintaining and sustaining communities, peoples, and nature. Coupled with this is the high degree of uncertainty associated both with water resource science, especially groundwater resources, and the growing penchant for holistic, integrated management of such resources across multiple scales, including the watershed scale.

We argue that in an adversarial setting focused on high uncertainty, wicked problems in which stakeholders' values and interests are poorly aligned, and in which the ultimate goal is one of sustainability, a sole focus on science as the source of policy impasses may well lead to unproductive problem-solving. This is because science can often be more a symptom of the impasse than its cause.

In such cases of "societal impasse," we argue that the adoption of a civic science approach increases the prospect that the scientific information being produced will impact key policy and management decisions, thus increasing the likelihood of water resource sustainability. Yet, the effective deployment of civic science in an adversarially charged "societal impasse" setting is unlikely to work since the kinds of information sharing, trust and cooperation central to the civic science concept do not exist in sufficient quantity. Therefore, government officials and other stakeholders need to figure out how to transition from the original setting of low/no trust to a properly designed and functioning collaborative capable of creating the proper conditions whereby civic science can thrive and contribute to effective water resource decision-making.

References

Ayres, Ian, and John Braithwaite. 1992. *Responsive regulation: Transcending the deregulation debate*. New York: Oxford University Press.

Blomquist, William. 1992. *Dividing the Waters: Governing Groundwater in Southern California.* San Francisco: ICS Press.

Barke, Richard P., and Hank Jenkins-Smith. 1993. "Politics and Scientific Expertise: Scientists Risk Perceptions and Nuclear Waste Policy," *Risk Analysis* 13 (4): 1585-95.

Berkes, Fikret, Johan Colding, and Carl Folke. Eds. 2006. *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press.

Canterbury Water. 2009. *Canterbury Water Management Strategy: Strategic Framework November 2009*. Retrieved November 5, 2009, from http://www.canterburywater.org.nz/downloads/011%20Canterbury%20Water%20Management%20Strategy%20document%2024%2011%2009..pdf

Carnavale, David G. 1995. *Trustworthy Governance: Leadership and Management Strategies for Building Trust and High Performance*. San Francisco, CA: Jossey Bass.

Cheng, Antony S., and Steven E. Daniels. 2005. "Getting to 'We': Examining the Relationship between Geographic Scale and Ingroup Emergence in Collaborative Watershed Planning," *Research in Human Ecology*, 12 (1): 30 – 43.

Clark, Fiona, and Deborah H. Illman 2001. "Dimensions of civic science: Introductory essay," *Science Communication* 23(1): 5-27.

Cohen, Steven 2006. *Understanding Environmental Policy*. New York: Columbia University Press.

Daniels, Steven E., and Gregg B. Walker 2001. *Working through environmental conflict: The collaborative learning approach*. Westport, CT: Praeger.

Dietz, Thomas, and Stern, Paul C. 2009. *Public Participation in Environmental Assessment and Decision Making.* Washington DC: National Academies Press.

Environment Canterbury (2007) Restorative Programme for Lowland Streams – Summary notes from Non-adversarial science workshop hosted by ECan (February); available at: http://www.selwyninfo.org/upload/File/SelwynHistoricInfo/ HIP_Water_System.pdf.

General Accounting Office. 2008. *Natural Resource Management: Opportunities Exist to Enhance Federal Participation in Collaborative Efforts to Reduce Conflicts and Improve Natural Resource Conditions*. Report to the Chairman, Subcommittee on Public lands and Forests, Committee on Energy and Natural Resources, U.S. Senate (February): 134 pp.

Hollings, C. S. 2006. "Foreword: The Backloop to Sustainability," in F. Berkes, J. Colding and C. Folke, eds., *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change*. Cambridge: Cambridge University Press: xv-xxi.

Jasanoff, Sheila. 1990. *The fifth branch: science advisers as policymakers*. Cambridge, MA: Harvard University Press.

Kates, Robert W., William C. Clark, Robert Corell, J. Michael Hall, Carlo C. Jaeger, Ian Lowe, James J. McCarthy, Hans Joachim Schnellhuber, Bert Bolin, Nancy M. Dickson, Sylvie Faucheux, et

al. 2001. "[Policy Forum: Environment and Development] Sustainability Science." *Science*, 292 (April 27): 641-42.

Khademian, Anne M. 1992. *The SEC and Capital Regulation: The Politics of Expertise.* Pittsburgh, PA: University of Pittsburgh Press.

Kickert, W. J. W., E. H. Klijn, and J.F. M. Koppenjan (eds.). 1997. *Managing Complex Networks*. London: Sage.

Kuhn, Thomas S. 1970. *The Structure of Scientific Revolutions.* 2nd ed., Chicago, IL: University of Chicago Press.

Lane, Neal. 1999. "The Civic Scientist and Science Policy," in *AAAS Science and Technology Policy Yearbook.* Available: http://www.aaas.org/spp/yearbook/chap22.htm

Lee, Kai N. 1993. *Compass and gyroscope integrating science and politics for the environment.* Washington, D.C.: Island Press.

Memon, P.A. and Skelton, P. 2007. Institutional Arrangements & Planning Practices to Allocate Freshwater Resources in New Zealand: A Way Forward. *New Zealand Journal of Environmental Law*, Volume 11 , 241-277.

Memon, P.A. and Weber, Edward P. 2010. Overcoming Obstacles to Collaborative Water Governance: Moving toward Sustainability in New Zealand. *The Journal of Natural Resource Policy Research. Vol 2(2), pp 103-116.*

Ministry for the Environment. 2004. Sustainable Water Programme of Action Stakeholder Reference Group: Report from the Water Allocation and Use Workshop held at the Ministry for the Environment on 25 June 2004.

Mitchell, B. 2007. 'Integrated catchment management and MSPs: Pulling in different directions?' in J. Warner. Ed. *Multistakeholder Platforms for Integrated Catchment Management*, Aldershot, UK: Ashgate Publishing: 67-88.

North, Douglass C. 2005. *Understanding the Process of Economic Change.* Princeton, NJ: Princeton University Press.

North, Douglass C. 1990. *Institutions, Institutional Change, and Economic Performance*. Cambridge: Cambridge University Press.

Nye, Joseph S., Jr. 1997. "The Decline of Confidence in Government," in J.S. Nye, Jr., P. D. Zelikow, and D. C. King, eds., *Why People Don't Trust Government*, Cambridge, MA: Harvard University Press: 1 – 18.

O'Leary, Rosemary, Robert F. Durant, Daniel J. Fiorino, and Paul S. Weiland. 1999. *Managing for the Environment: Understanding the Legal, Organizational, and Policy Challenges*. San Francisco, CA: Jossey-Bass.

Ostrom, Elinor. 1990. *Governing the Commons*. New York: Cambridge University Press.

Peters, Guy. 2001. *The Future of Governing*. Lawrence, KS: The University of Kansas Press.

Pielke, Roger A. 2007. *The honest broker making sense of science in policy and politics.* Cambridge: Cambridge University Press.

Pielke, Jr., R.A. and D. Sarewitz, 2005. "Bringing Society back into the Climate Debate," *Population and Environment*, 26 (3): 255-268.

Powell, Walter, Kenneth Kopet and Laurel Smith-Doerr. 1996. "Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology." *Administrative Science Quarterly* 41 (1): 116 – 45.

Pretty, Jules. 2003. "Social capital and the collective management of resources," *Science* 302: 1912–1914.

Roberts, Nancy C. 2000. "Wicked Problems and Network Approaches to Resolution." *International Public Management Review* 1 (1):

Sabatier, Paul, and Hank Jenkins-Smith. 1999. "The Advocacy Coalition Framework: An Assessment," In Paul Sabatier, ed., *Theories of the Policy Process*. Boulder, CO: Westview Press: 117-166.

Sabatier, Paul, Will Focht, Mark Lubell, Zev Trachtenberg, Arnold Vedlitz, and Marty Matlock. 2005. *Swimming Upstream: Collaborative Approaches to Watershed Management*. Cambridge, MA: The MIT Press.

Schmandt, Juergen. 1998. "Civic Science," *Science Communication* 20 (1): 62-69.

Stokes, Donald E. 1997. *Pasteur's quadrant basic science and technological innovation.* Washington, D.C.: Brookings Institution Press.

Tattersall, Philip J. 2010. "Community-based Auditing: Empowering the Community to Take Charge," http://www.loka.org/conf2003/phillip_tattersall.pdf (downloaded December 29, 2010).

Ti Kouka Consulting. 2008. *Selwyn Water Allocation Liaison Group: Review of Stakeholder Participation*. Accessed Nov. 7, 2008. http://www.selwyninfo.org/upload/File/SWALG/SWALG%20Review%20Report_Web.pdf.

Warner, Jerome. 2007. "The beauty of the beast: Participation for integrated catchment management," in J. Warner. Ed. *Multistakeholder Platforms for Integrated Catchment Management,* Aldershot, UK: Ashgate Publishing: 1-20.

Weber, Edward P. 1998. *Pluralism by the Rules.* Washington DC: Georgetown University Press.

Weber, Edward P. 2003. *Bringing Society Back In: Grassroots Ecosystem Management, Accountability, and Sustainable Communities.* Cambridge, MA: MIT Press.

Weber, Edward P., and Khademian, Anne M. 2008a. "Wicked Problems, Knowledge Challenges, and Collaborative Capacity Builders in Network Settings," *Public Administration Review 68*(2), 333-349.

Weber, Edward P., and Khademian, Anne M. 2008b. "Managing Collaborative Processes: Common Practices, Uncommon Circumstances," *Administration and Society* 40 (5): 431-464.

Weber, Edward P. 2008. "Getting to Resilience in a Climate Protected Community: Rationality, Ideas, and Culture," Prepared for the Symposium on Enhancing Resilience to Catastrophic Events, The Institute for Policy and Governance, Blacksburg, VA (November 18-19).

Weber, Edward P. 2009. "Explaining Institutional Change in Tough Cases of Collaboration: 'Ideas' in the Blackfoot Watershed," *Public Administration Review* 69 (2): 314-327.

Weible, Christopher M. 2008. "Expert-based Information and Policy Subsystems: A Review and Synthesis," *Policy Studies Journal* 36 (4): 615-635.

Williamson, Elizabeth. 2008. "Scientists take complaints about interference to Hill," *Washington Post* (January 16): A13.

5)

[1] The other possibility here is the use of hierarchy, or national authority. Two stakeholders suggested that the "national government might need to step in and swing a big stick" to force a resolution of the impasse. Yet, neither think it is the best way forward as a first step, in part because it undermines ECan's authority and it is likely not to be considered legitimate by most people (interviews 3/16/09B, 3/20/09F). Another stakeholder suggests that the national government write a new law that explicitly inserts the precautionary principle into the RMA, thus giving ECan greater power to stop water consents when scientific uncertainty precludes a clear sense that the water abstraction will *not* harm the environment. Yet, the ascent to power of the conservative National Party in early 2009 makes this course of action unlikely for some years to come.

[2] The purpose of the LGA 2002 is to empower local government to promote social, economic and environmental well-being of their communities.

7)

[3] Empirical support for the analytical bias of academic disciplines can be found in Barke and Jenkins-Smith (1993). Similarly, others discuss biases in academic disciplines and theeffects on public policy (e.g., Cohen 2006), while the public administration literature has long recognized that many experts, scientists included, are susceptible to the "trained incapacity" problem, wherein experts in a particular field or discipline become less skilled at recognizing or seeing the broader "big picture" implications of their decision-making (Knott and Miller 1987).

[4] see www.wet.org.nz

[5] The concept here is that participants are dedicated to facilitating meaningful change while *including* existing livelihoods in plans for the "place's" future, all while recognizing that modifications to such livelihoods will be needed to achieve the ultimate goal of long-term problem solving success.

[6] Daniels and Walker (2001, 184); Weber (2003, 87).

[7] Daniels and Walker (2001, xviii, 181); Weber (2003, 87).

[8] Daniels and Walker (2001, 184, 187); Weber (2003, 89).

[9] Daniels and Walker (2001); Weber (2003, 237).

[10] Daniels and Walker (2001, 184); Weber (2003, 88).

[11] Daniels and Walker (2001, 184).

[12] Daniels and Walker (2001, 181); Weber (2003, 88).

[13] Daniels and Walker (2001, 72-73), Weber (1998, 115-16; 2003, 4, 77), and Sabatier, Leach, Lubell and Pelkey (2005, 195).